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Monitoring Jupiter's atmospheric general circulation with ground-based observations obtained with small telescopes

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Abstract

The general circulation of Jupiter's atmosphere is dominated by a system of zonal winds alternating in latitude and related to the Bands and Zones structure of the planet. The zonal winds have been retrieved in several occasions by analyzing cloud motions in spacecraft observations of the planet and with HST observations [1,3,6,7]. In spite of some changes in the bands, the zonal wind system is stable and robust at most latitudes. Here we present a study of the overall zonal winds of Jupiter using images acquired over 2011 by a large network of amateur observers contributing to the PVOL-IOPW database [5] and operating small telescopes. In spite of the relatively small spatial resolution of the images zonal winds were retrieved using an automatic correlation technique that allowed extracting mean zonal winds in several dates. This opens the possibility to study regularly short- and long-term changes in the jet streams of Jupiter analyzing ground-based observations obtained by amateur astronomers.

1. Introduction

The system of zonal winds of Jupiter is very stable and it correlates well with the visual banded structure of the planet. Taken as a whole there have been very few changes since the early measurements obtained by the Voyagers in 1979 [6] and the latest wind fields from HST observations in 2008 [1]. Although some of the bands morphology changes periodically, the wind profile shows a remarkable stability. Furthermore, this zonal wind profile is not affected by strong dynamic perturbations in the atmosphere such as convective storms or large impacts such as those of 1994 and 2009 [8]. Nevertheless, there are some changes in the zonal winds of Jupiter. The most conspicuous changes happen occasionally in the North Temperate Belt linked to planetary size disturbances [2], in the North Equatorial Belt linked to the appearance of large-scale hot-spots and in the South Equatorial Belt linked to zonal distribution of chevrons and waves [9].
Studies of Jupiter winds have generally required either very high-resolution observations, attainable only from HST or spacecraft missions, or detailed tracking of features over many different images to track their motions with enough accuracy. Here we show that a cloud correlation technique works also for ground-based observations with small telescopes obtained by keen amateur observers. We present results for 2011, studying the short-term variability and the mean 2011 zonal winds.

2. Observations

The PVOL-IOPW database is a repository of giant planets observations contributed by an international network of amateur astronomers in the framework of the International Outer Planets Watch Atmospheres node. It stores a large number of images (2095 observations of Jupiter for the latest observation campaign extending from May 2011 to April 2011) and it allows web-base queries with several criteria [5]. These observations allow a wide temporal coverage of Jupiter and Saturn The quality of the observations is very variable but some observers obtain images with spatial resolutions down to 0.5'' (1500 km over the Jovian disk at opposition). The main advantage of these observations opposite to professional observatories images is the wider temporal coverage of them; there are observations of almost every day when Jupiter is visible from the Earth.

3. Analysis

We selected pairs of high-quality images separated by one or two planetary rotations. This normally requires comparing observations from two different observers. Selected images were navigated, and projected in cylindrical maps. Maps were corrected from limb-darkening effects with a Lambert function and compared using a cloud correlation algorithm

initially designed for analysis of high-resolution spacecraft images [4]. Instead of performing a correlation of the images in terms of two-dimensional small pixel boxes we modified the algorithm to perform correlation of zonal scans in the images [3]. Navigation errors, small mistakes in the image timing given by the observers and planet axis orientation problems were corrected from the wind results. We verified the results in some specific cases by manually tracking some cloud features over several images validating our technique.

4. Results

Jupiter opposition was in October 22, 2011 and we analyzed image pairs from September to December 2012 in four temporal blocks. We obtain wind profiles of different dates that can be used to study short-term wind variability and to obtain a mean wind profile for the 2011. Figure 1 shows a summary of the main zonal wind for 2011. Short-term variability is at most latitudes below the measurement error but signatures of wind variability are found at the North Temperate Belt and the North Equatorial Belt possibly in connection with the visual aspect of large hot-spot features.

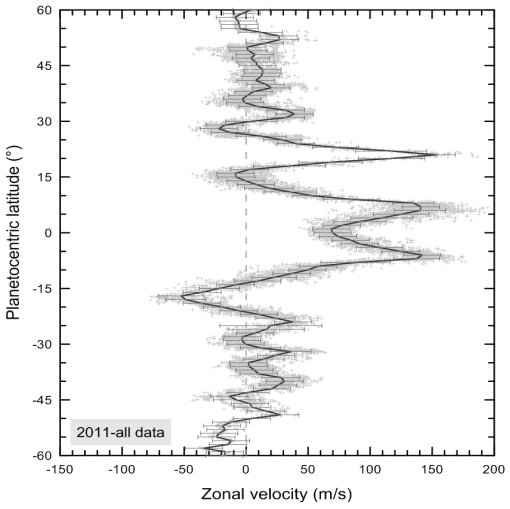

Figure 1: Mean 2011 wind profile using IOPW images. The black line is the mean value of the velocity binned in 1º latitude boxes. The gray dots are all the 21,000 individual measurements.

5. Summary and Conclusions

Our results support the use of amateur images to monitor the zonal winds in Jupiter and its possible variations. When comparing the wind profiles at different dates we do not observe any meaningful variation. When we perform the same comparison with profiles of previous years we see that there are some jets on Jupiter that show some changes as for example the hot spot region or the jet at 30º of latitude.

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References

[1] Asay-Davis, X.S. Marcus, P.S., Wong, M.H. and De Pater, I: Changes in Jupiter's zonal velocity between 1979 and 2008, Icarus, 211, pp. 1215-1232, 2011.

[2] Barrado-Izagirre, N, Pérez-Hoyos, S., García-Melendo, E. and Sánchez-Lavega, A.: Evolution of the cloud field and wind structure of Jupiter's highest speed jet during a huge disturbance, A&A, 507, pp. 513-522, 2009.

[3] García-Melendo, E. and Sánchez-Lavega, A.: A study of the stability of the jovian zonal winds from HST images: 1995-2000, Icarus, 152, pp. 316-330, 2001.

[4] Hueso, R., Legarreta, J., García-Melendo, E., Sánchez-Lavega, A., Pérez-Hoyos, S.: The jovian anticyclone BA II. Circulation and interaction with the zonal jets, Icarus, 203, pp 499-515, 2009.

[5] Hueso, R. et al.: The international outer planets watch atmospheres node database of giant planet images, PSS, 59, pp. 1152-1159, 2010.

[6] Limaye, S.S.: Jupiter: New estimates of the mean zonal flow at the cloud level, Icarus, 65, pp. 335-352, 1986.

[7] Porco, C.C. and 30 collegues: Cassini imaging of Jupiter's atmosphere, satellites and ringd. Science , 299, pp. 1541-1547, 2003.

[8] Sánchez-Lavega, A. et al., The impact of a large object on Jupiter in 2009 July. ApJL, 715, 2 L150, 2010.

[9] Simon-Miller, A.A., et al.,Longitudinal variation and waves in Jupiter's south equatorial wind jet. *Icarus*, 218, 817-830, 2012.